User's Guide

FMA 3200/3200ST/3400/3400ST Series
Thermal Mass Flow Controllers

omega.com®
OMEGA®

OMEGAnet® Online Service omega.com	Internet e-mail info@omega.com

Servicing North America:

U.S.A.:
ISO 9001 Certified
One Omega Drive, P.O. Box 4047
Stamford, CT 06907-0047
TEL: (203) 359-1660
FAX: (203) 359-7700
e-mail: info@omega.com

Canada:
976 Bergar
Laval (Quebec) H7L 5A1, Canada
TEL: (514) 856-6928
FAX: (514) 856-6886
e-mail: info@omega.ca

For immediate technical or application assistance:

U.S.A. and Canada: Sales Service: 1-800-826-6342/1-800-TC-OMEGA®
Customer Service: 1-800-622-2378/1-800-622-BEST®
Engineering Service: 1-800-872-9436/1-800-USA-WHEN®

Mexico:
En Español: (001) 203-359-7803
e-mail: espanol@omega.com
FAX: (001) 203-359-7807
info@omega.com.mx

Servicing Europe:

Czech Republic:
Frystatska 184, 733 01 Karviná, Czech Republic
TEL: +420 (0)59 6311899
FAX: +420 (0)59 6311114

Toll Free: 0800-1-66342
e-mail: info@omegashop.cz

Germany/Austria:
Daimlerstrasse 26, D-75392 Deckenpfronn, Germany
TEL: +49 (0)7056 9398-0
FAX: +49 (0)7056 9398-29
Toll Free in Germany: 0800 639 7678
e-mail: info@omega.de

United Kingdom:
ISO 9002 Certified
One Omega Drive, River Bend Technology Centre
Northbank, Irlam, Manchester
M44 5BD United Kingdom
TEL: +44 (0)161 777 6611
FAX: +44 (0)161 777 6622
Toll Free in United Kingdom: 0800-488-488
e-mail: sales@omega.co.uk

READ THIS MANUAL COMPLETELY BEFORE ATTEMPTING TO CONNECT OR OPERATE YOUR FLOW SENSOR. FAILURE TO DO SO MAY RESULT IN INJURY TO YOU OR DAMAGE TO THE FLOW CONTROLLER.

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A. *Introduction*

1. Unpacking

All units are suitably packaged to prevent damage during shipping. If external damage is noted upon receipt of the package, please contact **Omega Engineering** immediately.

Open the package from the top, taking care not to cut too deeply into the package. Remove all the documentation and contents. Take care to remove all the items and check them against the packing slip. The products should also be checked for any concealed shipping damage. If any shortages or damage is noted, please contact Omega Engineering to resolve the problem.

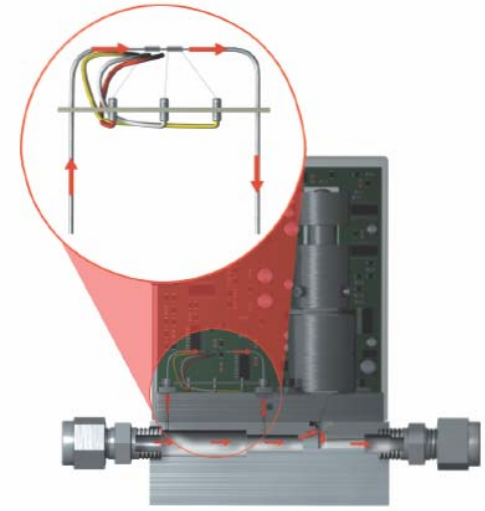
Typical Contents of Box: Controller, Calibration Certificate & Manual
FMA 3200/3200ST shown; FMA 3400/3400ST have an integrated display.

Caution: Take care not to ***drop*** your controller. Read the installation section of this manual before providing power or tubing connections to the unit. Any damage caused by improper installation or careless handling will not be repaired under warranty (see limited warranty on page 25 for more details).

2. Product Overview and Principle of Operation

The FMA 3200/3400 Series Mass Flow Controllers from Omega Engineering are capable of measuring and controlling the flow of virtually any clean, dry gas as low as 0-20 sccm or as high as 0-10 l/min. Repeatable results are achieved using a patented thermal mass flow

sensor design. This proven design minimizes zero drift while maintaining fast response and linear outputs with virtually no maintenance.



The FMA 3200/3400 Series utilizes thermal flow sensing technology. A portion of the gas flowing through the unit is redirected into a small sensor tube. This tube has two coils on the outside. The first coil introduces a small amount of heat into the gas stream. As the gas passes through the tube heat is transferred from one coil to the other. The flow rate is proportional to the amount of heat transfer. Smart electronics analyze the amount of temperature change in the second coil and provide a linearized analog output. A patented system insures that the zero remains stable and the sensor is extremely repeatable.

Flow in the FMA 3200/3400 Series is controlled by a proportional solenoid valve with active servo electronics. The flow measurement signal is analyzed by micro-processor controlled electronics and compared to a set-point. Adjustments are then made to the valve in order to achieve the required flow rate. The set point can be either externally input via a 0-5VDC signal or in the case of the FMA 3400/3400ST Series it can be input manually on the unit.

The output of the thermal mass flow sensor is directly related to the specific heat characteristic of the gas being measured. A sensor is calibrated for one gas but may be used with other gases by applying a correction factor to the output. The calibration gas for each specific flow controller is detailed on the product label.

B. Installation

Caution: Do not exceed the pressure, temperature or power operating ranges detailed in the SPECIFICATIONS section of this manual. Omega Engineering shall not be liable for any damage or injury caused by incorrect operation of their products.

1. General Considerations

It is recommended that a safety shut-off valve be installed upstream (before) of the controller.

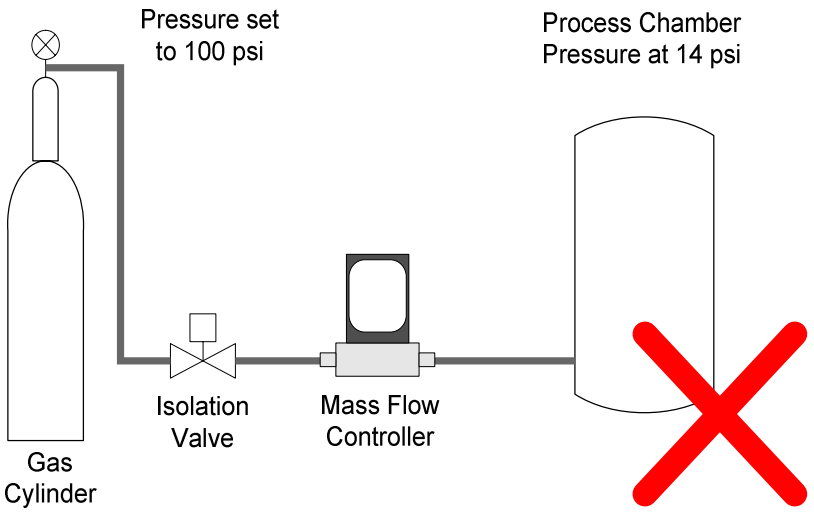
All wetted parts should be checked for compatibility with the gas to be used. If there are any incompatibilities eg. highly corrosive gas, then the

unit may be damaged or fail prematurely. Such damage will not be repaired under warranty.

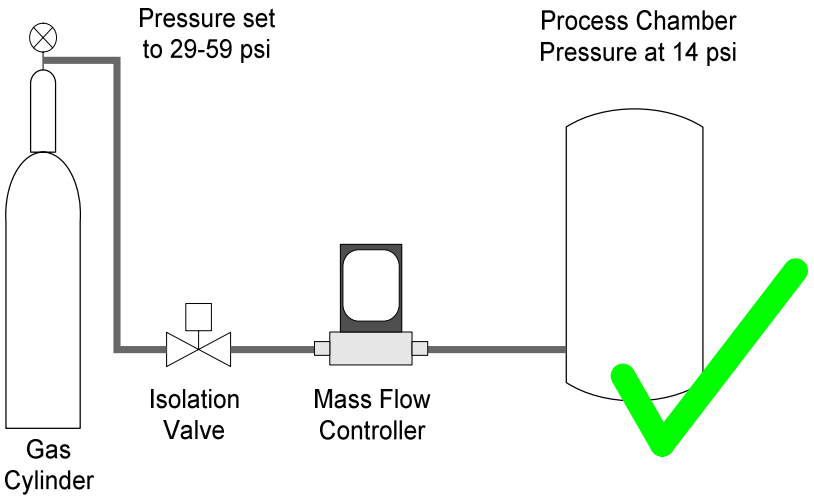
Units should be installed in a clean, dry environment with an ambient temperature that is as stable as possible. Avoid areas with strong magnetic fields, strong air flows or excessive vibration.

In order to operate the differential pressure across the controller should be in the range 15-45psid (1-3 bar). For optimum performance a differential pressure of 25psid is recommended.

For Example, consider the following system:



The differential pressure across the flow controller in this system would be 100 psi – 14 psi = 86 psid. Consequently the flow controller would NOT be able to control flow. For the unit to operate at optimum performance the supply pressure from the gas cylinder would need to be lowered to 39 psig to give 39 psi -14 psi = 25 psid.



2. Mounting the Flow Controller.

The FMA 3200/3400 Series controllers have no particular orientation or installation requirements so may be mounted in any convenient position.

It is recommended that units be fixed to a suitable substrate using the two 4-40 mounting holes provided.

Mounting View from Bottom
(mounting hardware not included with sensor)

3. Tubing Connections

All tubing must be clean, dry and purged with clean dry air before installation of the FLO-CONTROLLER®.

If the gas to be used may contain particles then a filter (20 microns or less) should be installed upstream of (before) the unit.

When connecting the sensor to the tubing, take care not to over-tighten the fittings or leaking may occur.

Caution: Only use the fittings factory installed on the unit. If the fittings are removed the calibration of the unit may be effected and leaking may occur. If different fittings are required please contact the Omega Engineering Customer Service Department for assistance.

4. Electrical Connections

Caution: Incorrect wiring may cause severe damage to the unit. Applying an AC voltage (115VAC or 230VAC) directly to the unit will cause damage. Read the following instructions carefully before making any connections.

a) Overview

The FMA 3200/3400 Series provides a 0-5VDC analog output proportional to the flow rate. This output may be connected to a display, data acquisition system or voltmeter with an impedance of greater than 2.5 kΩ (kilo ohms).

The flow controller needs to be supplied with a 0-5 VDC set point signal to enable control. On the FMA 3400/3400ST Series this may be generated internally by altering the set-point potentiometer on the front panel of the unit.

A stable D.C. power supply is required to operate the unit. The voltage and current requirements depend on the configuration of the unit. Full details may be found in the Specification section of this manual.

Connecting wires should be as short as possible to avoid voltage drops. Twisted conductor cable should be used if the length of the wiring is to be longer than 2 meters.

Units are supplied with either a 6 pin mini DIN type connector (requires mating cable assembly), a 9 Pin D Sub connector or 15 Pin D Sub connector.

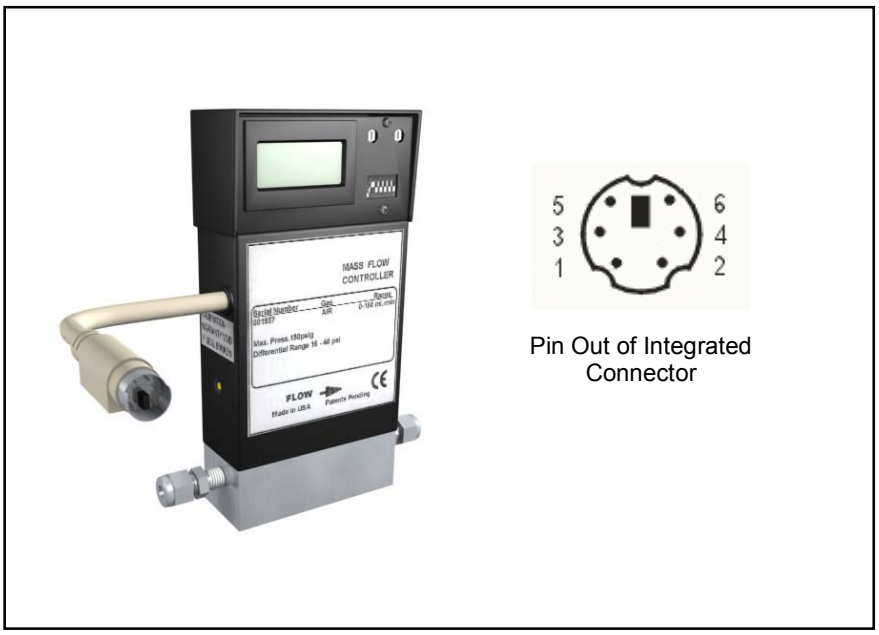
Caution: Cutting off the integrated connectors on the unit IS NOT RECOMMENDED and will void the product warranty. Mating cables should be ordered along with each unit.

Electrical connections to the units are made as detailed in the following sections.

b) Connecting The 6 Pin Mini Din Connector

Using a suitable mating connector the pins of the integrated connector should be wired as follows:

Connecting To The Integrated 6 Pin Connector



Pin Out of Integrated Connector

Pin 2 should be connected to the Positive of the power source.

Pin 6 should be connected to the Negative (Ground) of the power source.

Pin 3 provides the signal output and should be connected to the positive terminal of the display, data acquisition system or voltmeter.

Pin 1 is the signal negative (ground) and should be connected to the negative (Ground) terminal of the display, data acquisition system or voltmeter.

Pin 4 provides the input signal and should be connected to the positive terminal of the voltage source. The (0-5VDC) voltage control signal should be supplied from a low impedance source.

Pin 5 is the input signal negative (ground) and should be connected to the negative (Ground) terminal of the voltage source.

Caution: Avoid high voltage static discharges to the input signal connection. Do not short the input/output signal wires or allow them to contact the power wires at any time. DAMAGE WILL RESULT!

c) Connecting The 6 Pin Mini Din Connector & FMA 3000C Cable

The two mating connectors should be pushed together and the pigtail leads wired as follows:

Connecting To The Integrated 6 Pin Connector Using A FMA 3000C Cable

The **RED** wire should be connected to the Positive of the power source.

The **BLACK** wire should be connected to the Negative (Ground) of the power source.

The **ORANGE** wire provides the signal output and should be connected to the positive terminal of the display, data acquisition system or voltmeter.

The **BROWN** wire is the signal negative (ground) and should be connected to the negative (Ground) terminal of the display, data acquisition system or voltmeter.

The **YELLOW** wire provides the input signal and should be connected to the positive terminal of the voltage source. The (0-5VDC) voltage control signal should be supplied from a low impedance source.

The **GREEN** wire is the input signal negative (ground) and should be connected to the negative (Ground) terminal of the voltage source.

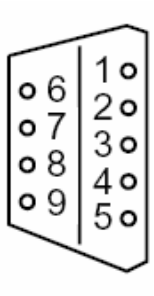
The wire colors above describe the pigtail leads of the FMA 3000C cable assembly and may not correspond with the internal wiring of your flow sensor.

Caution: Avoid high voltage static discharges to the input signal connection. Do not short the input/output signal wires or allow them to contact the power wires at any time. DAMAGE WILL RESULT!

d) Connections For The 9 Pin D Sub Connector

Using a suitable mating connector the pins of the integrated connector should be wired as follows:

Connecting To The Integrated 9 Pin Connector



Pin Out of Integrated Connector

PIN 3 should be connected to the Positive of the power source.

PIN 4 should be connected to the Negative (Ground) of the power source.

PIN 2 provides the signal output and should be connected to the positive terminal of the display, data acquisition system or voltmeter.

PIN 8 is the signal negative (ground) and should be connected to the negative (Ground) terminal of the display, data acquisition system or voltmeter.

Pin 6 is the input signal and should be connected to the positive terminal of the voltage source. The (0-5VDC) voltage control signal should be supplied from a low impedance source.

Pin 7 is the input signal negative (ground) and should be connected to the negative (Ground) terminal of the voltage source.

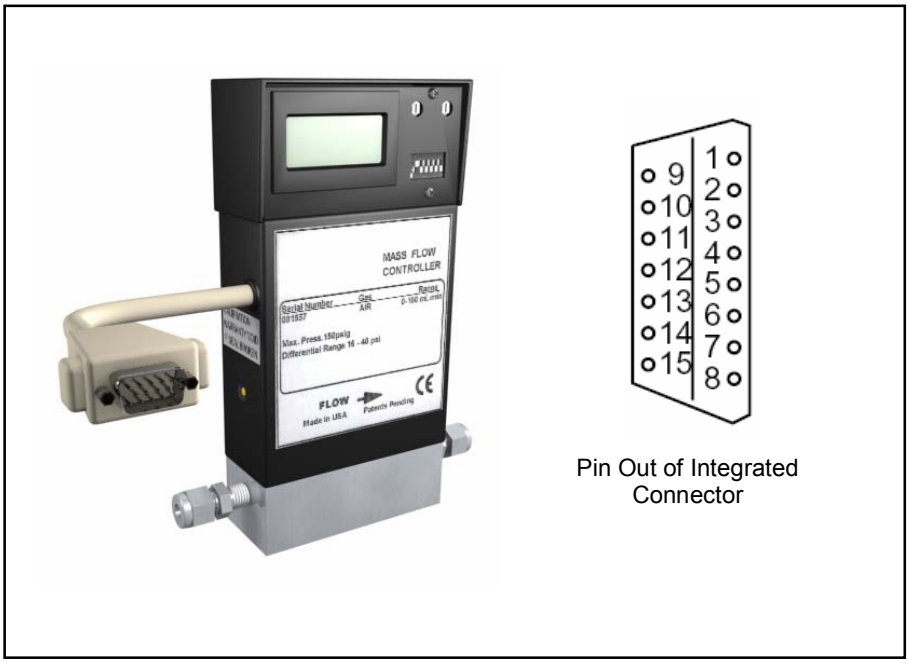
Pins 1, 5, and 9 are not used.

Caution: Avoid high voltage static discharges to the input signal connection. Do not short the input/output signal pins or allow them to contact the power connections at any time. DAMAGE WILL RESULT!

e) Connections For The 15 D Sub Connector

Using a suitable mating connector the pins of the integrated connector should be wired as follows:

Connecting To The Integrated 15 Pin Connector



Pin Out of Integrated Connector

PIN 7 should be connected to the Positive of the power source.

PIN 5 should be connected to the Negative (Ground) of the power source.

PIN 2 provides the signal output and should be connected to the positive terminal of the display, data acquisition system or voltmeter.

PIN 10 is the signal negative (ground) and should be connected to the negative (Ground) terminal of the display, data acquisition system or voltmeter.

Pin 8 is the input signal and should be connected to the positive terminal of the voltage source. The (0-5VDC) voltage control signal should be supplied from a low impedance source.

Pin 1 is the input signal negative (ground) and should be connected to the negative (Ground) terminal of the voltage source.

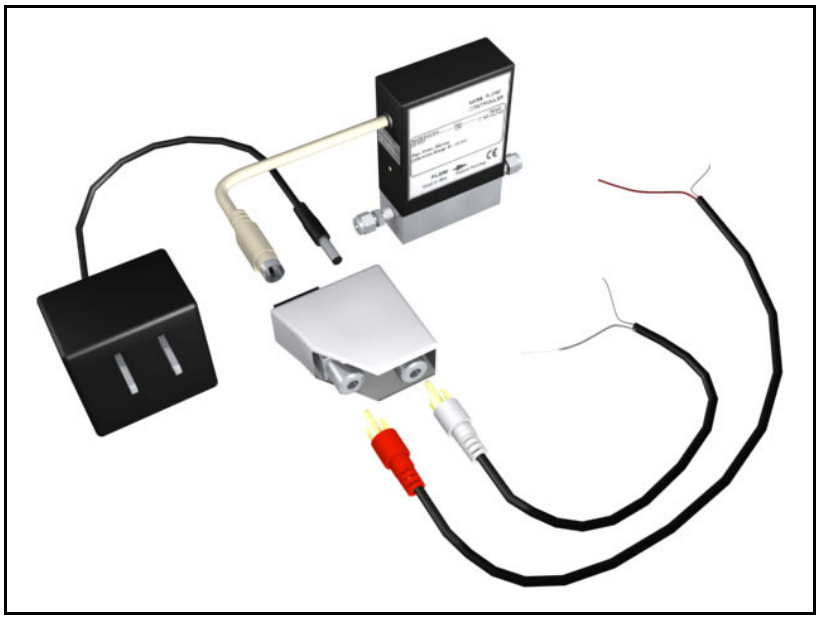
Pins 3, 4, 6, 9, 11, 12, 13, 14 and 15 are not used.

Caution: Avoid high voltage static discharges to the input signal connection. Do not short the output signal pins or allow them to contact the power connections at any time. DAMAGE WILL RESULT!

f) Using a 0-5VDC Input / Output Power Adapter Package.

An optional 0-5VDC Input / Output Power Adapter Package is available for use with the FMA 3200/3400 Series. This consists of a power source (115VAC or 230VAC), a connection hub and two cable assemblies with pig-tail (soldered wire) ends. This should be assembled as shown in the following diagram.

Assembling a FMA 3215PW Power Adapter Package
(the FMA 3223PW Power Adapter Package is similar)



The **RED** connector should be inserted in the **RED** socket on the connection hub. The **WHITE** connector should be inserted in the **WHITE** socket on the connection hub.

The cable with a **RED** connector provides the input signal. The **RED** wire of this cable should be connected to the positive terminal of the voltage source. The (0-5VDC) voltage control signal should be supplied from a low impedance source. The **bare** wire of this cable assembly is the input signal negative (ground) and should be connected to the negative (Ground) terminal of the voltage source.

The cable with a **WHITE** connector provides the signal output. The **WHITE** wire should be connected to the positive terminal of the display, data acquisition system or voltmeter with an impedance of greater than 2.5 kΩ (kilo ohms). The **bare** wire of this cable assembly is the signal negative (ground) and should be connected to the negative (Ground) terminal of the display, data acquisition system or voltmeter.

Caution: Avoid high voltage static discharges to the input signal connection. Do not short the output signal wires or allow them to contact the power wires at any time. DAMAGE WILL RESULT!

C. Operation

1. Warm Up

Before applying power to the unit check all tubing and electrical connections. Once correct installation is verified switch on the power. The unit should then be allowed to warm up for 5 minutes before gas pressure is applied.

2. Verification of Zero

Flow through the unit should be stopped by sealing or capping the inlet of the controller. It is not adequate to only stop flow by turning off the gas supply or closing a valve as there may be a leak in the system. This would give a false reading.

After 5 minutes, the zero should be stable when there is no flow through the unit. If after 10-15 minutes the output is still not zero volts (within ±0.05 volts) the unit should be adjusted as detailed in section C part 6.

It should be noted that power supply voltage variations and changes in ambient temperature can have an effect on zero readings.

3. Flow Readings

Each controller is factory calibrated for a specific flow range and gas (or gas mixture). The calibration gas and flow range are shown on the unit's label and calibration certificate.

By monitoring the voltage output signal it is possible to determine the flow rate of the gas. Units are configured so that an output signal of 5.0VDC is provided when the maximum flow (i.e. Full Scale flow) is passing through the unit. The output signal is linear and scaleable enabling calculation of flow rates with in the sensor's range. For example:

> For a flow range of 0-500sccm:
>
> At 500sccm the output signal would be 5VDC
>
> If the output signal were 3.5VDC then the flow rate would be:
>
> $500 \div 5 \times 3.5 = 350$sccm

If the maximum flow rate is exceeded non-linear and inaccurate readings will result.

Units may be used for gases other than the calibration gas. In this case a "K Factor" would need to be applied and a corrected value calculated using the following formula:

$Q_1 / Q_2 = K_1 / K_2$

Q_1 is the flow rate of the new gas
Q_2 is the flow rate of the original calibration gas
K_1 is the K factor of the new gas
K_2 is the K factor of the original calibration gas

$Q_1 = (K_1 / K_2) Q_2$

If K_2 is larger than K_1 then linear results will only be achieved if the unit does not exceed $5(K_1/ K_2)$VDC for the full scale output.

Example 1
For a 0-200sccm unit calibrated for air the flow at 5.0VDC would be 200sccm. The K factor for air is 1. If the unit is used with Helium (K factor 1.454 relative to air) then the flow at 5VDC (i.e. the maximum flow) would be (1.454/1)200 = 290.8 sccm

Example 2
For a 0-10.0 l/min unit calibrated for Argon the flow at 5.0VDC would be 10.0l/min. The K factor for Argon is 1.45. If the unit is used with Carbon Dioxide (K factor 0.74) then the flow rate 5.0VDC would be (0.74/1.45)10.0 = 5.10l/min

The accuracy of readings using K factors is not as good as that achieved for the calibration gas. The accuracy obtained (typically ±3% for K factors similar to the calibration gas) depends on the gas being used and the flow rate.

For a list of common K Factors see Section J.

4. Changing The Flow Rate Set-Point (Using An External Voltage Source)

The required flow rate is selected by adjusting the set-point voltage. The normal control signal voltage is 0-5VDC with 0VDC corresponding to zero flow and 5VDC being equivalent to the maximum rated flow of the unit. This input is linear and scaleable allowing different flow rates within the range of the unit to be selected. For example:

For a flow range of 0-500sccm:

A 5 VDC Input Signal would correspond to a flow rate of 500sccm

If a flow rate of 300sccm were required then the set-point would be:

(300 ÷ 500) × 5 = 3.0VDC

If a gas other than the calibration gas is used then the adjusted maximum (full scale) flow for the unit should be calculated using the K Factor for that gas (see section C3 above).

A zero or negative set-point voltage will cause the solenoid valve to close fully. Whilst closed, the valve is configured to withstand pressures up to 60 psig (higher pressures on request).

Caution: The flow controller valve will open if the pressure exceeds 60psig. For safety it is recommended that a separate positive shut-off valve is installed upstream of the controller.

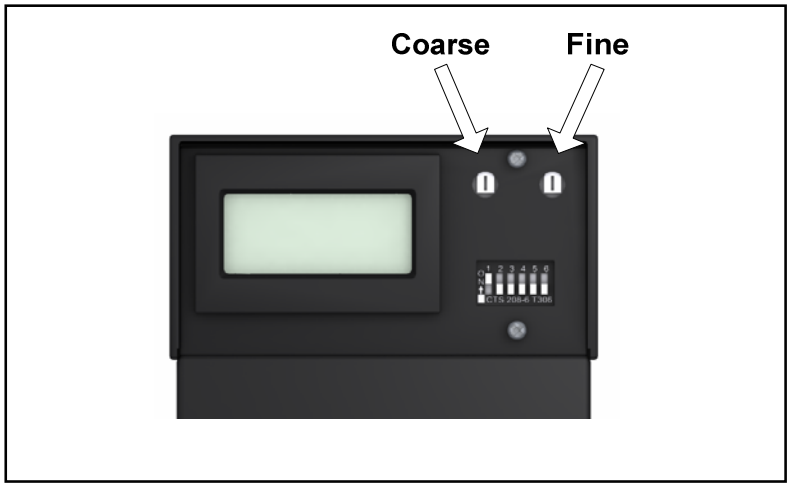
5. Changing The Flow Rate Set-Point – FMA3400/3400ST Series Only

On the FMA 3400/3400ST Series the set-point may be input from an external source or be supplied internally.

For an external set-point, dip switch 1 should be **OFF** and dip switch 2 **ON**. See section C4 above for details of how to adjust the set-point using an external voltage source.

For an internal set-point, dip switch 1 should be **ON** and dipswitch 2 **OFF**. Adjustment of the internal set-point is made by turning the coarse and fine set-point potentiometers on the front panel of the display, with the gas is flowing, until the desired flow rate is achieved.

FMA 3400/3400ST Series Set-Point Potentiometers



6. Power Save Mode.

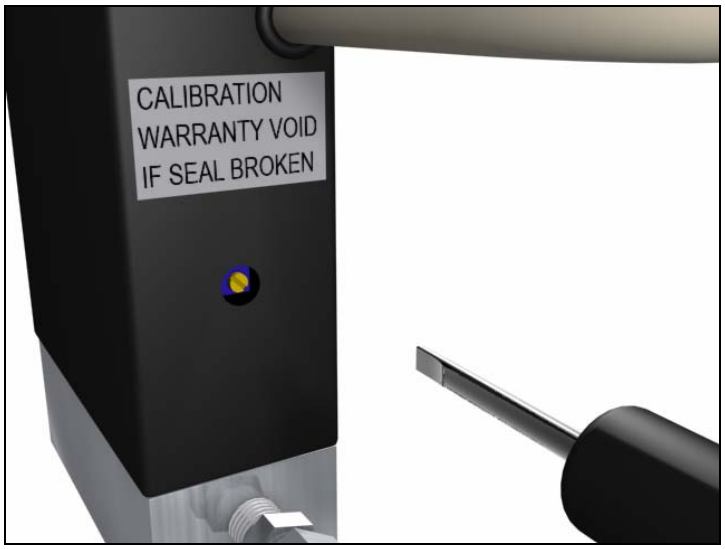
To improve valve performance and reliability over time, the FMA 3200/3400 Series features a Power Save Mode. This is activated after a prolonged application of a zero or negative set-point. When a control voltage greater than 0 VDC is applied after the Power Save Mode has been initiated there may be a short delay (1-2 secs) before the valve actuates.

7. Zero Adjustments

The zero should be checked as detailed in section C part 2. If an adjustment is needed the Zero Potentiometer should be carefully turned until the output (VDC) becomes zero.

Caution: Do NOT adjust the Gain Potentiometer when adjusting the zero or the unit will need to be recalibrated.

Making Zero Adjustments Using a Small Flathead Screwdriver



Care should be taken to only make small adjustments to the zero potentiometer. If too much of an adjustment is made and difficulties are being experienced in achieving a zero reading then turn the potentiometer fully anti-clockwise and begin making small clockwise adjustments until a zero reading is obtained.

8. Recalibration

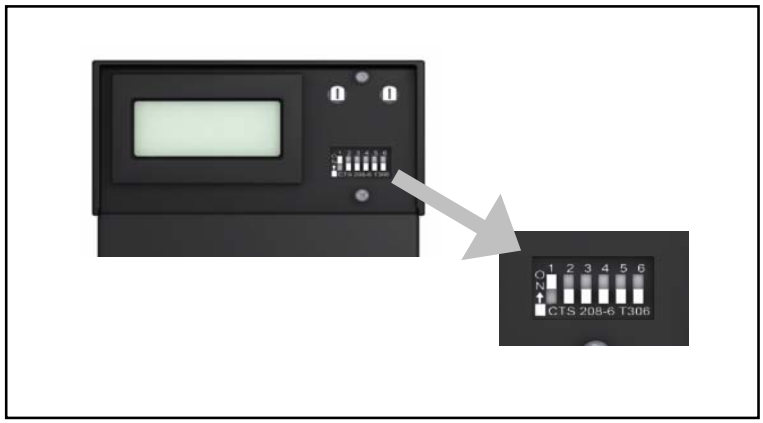
If recalibration is required please contact the Omega Engineering Customer Service Department.

9. Changing the Calibration Gas – FMA 3400/3400ST Series Only

The FMA 3400/3400ST Series may be calibrated for up to three gases. These gases, their corresponding flow ranges and accuracy specifications are detailed on the calibration certificate.

The calibration gas required is determined by selecting the corresponding dip switch on the front panel of the display.

FMA 3400/3400ST Series Dip Switches



Dip switch 4 is allocated to the primary calibration gas.
Dip switch 5 is allocated to the second calibration gas (if applicable).
Dip switch 6 is allocated to the third calibration gas (if applicable).

To select the gas, the dip switch should be turned **ON**. All other switches allocated to gases (i.e. 4, 5 or 6 except the required switch/gas) should be set to **OFF.**

D. Maintenance and Product Care

1. General

Inlet filters should be periodically checked and cleaned or replaced as necessary.

Regularly check all electrical and process connections for damage or deterioration.

If the sensor is to be stored, keep both the inlet and outlet ports sealed.

Do not allow any liquid or moisture to enter the sensor or damage will occur.

2. Returning Units for Repair or Recalibration

To return a unit for repair or recalibration please contact the Omega Engineering Customer Service Department. An Authorized Return (AR) number will then be issued. The AR number should then be noted on the outside of the package and on any correspondence. Further details may be found on page 25 of this manual.

E. Specifications

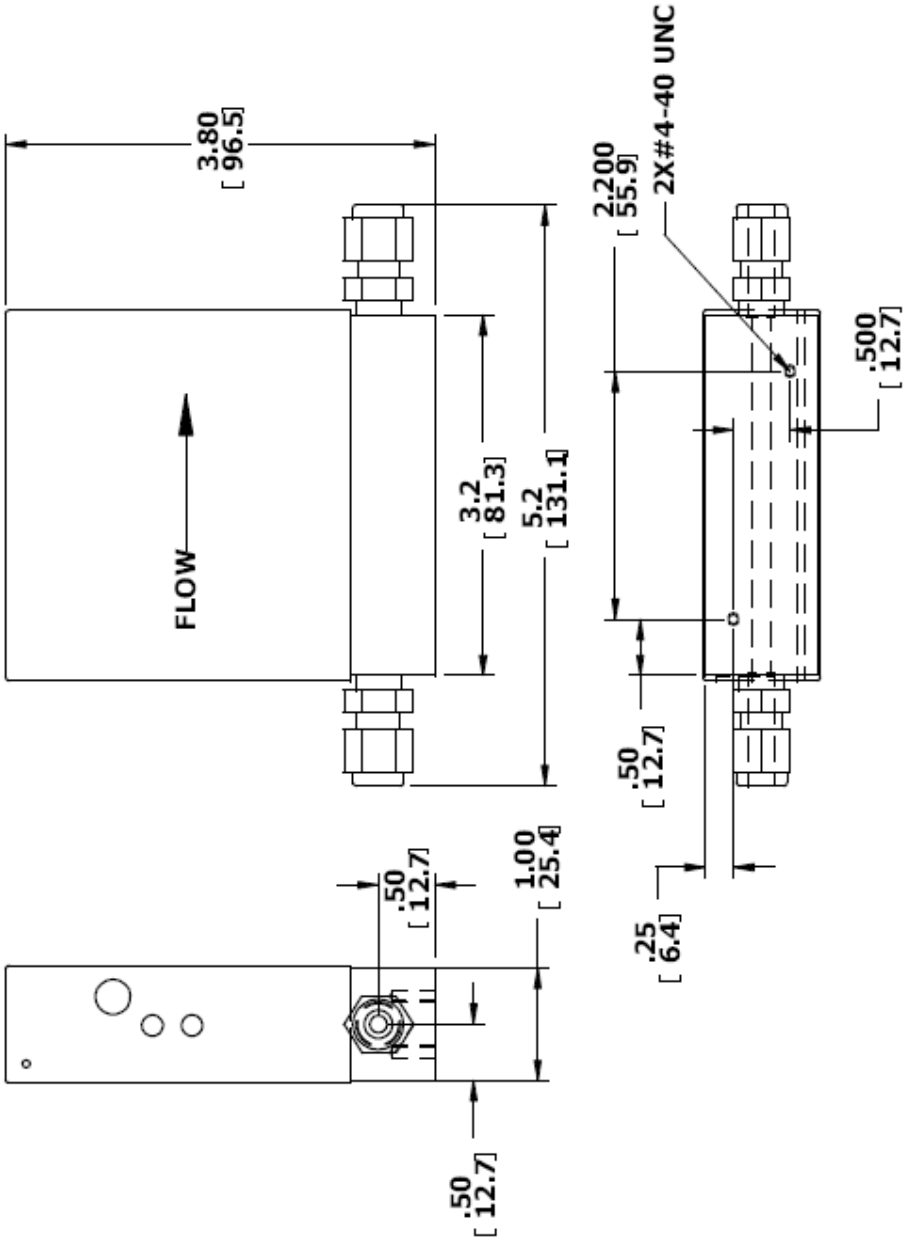
Series	FMA 3200	FMA 3400	FMA 3200ST	FMA 3400ST
Accuracy (including linearity)	±1.5% of Full Scale*	±1.5% of Full Scale* Second and third gases ±3.0% F.S.*	±1.5% of Full Scale*	±1.5% of Full Scale* Second and third gases ±3.0% F.S.*
Repeatability	±0.25% Full Scale*			
Pressure Rating	150 psig (10.3 bar)		500 psig (34.5 bar)	
Pressure Sensitivity	±0.02% Full Scale* per psi (per 69 mbar)			
Temperature Rating	Operating Range: 5 to 55ºC Recommended Range (for best performance) : 10 to 40ºC Storage Range: 0 to 70ºC			
Temperature Sensitivity	±0.15% F.S.* or less per ºC			
Valve	Normally Closed Positive Shut-off up to 60psig (4 bar)			
Body Leak Integrity	$1x10^{-7}$ sccs of He			
Wetted Materials	Aluminum 304 Stainless Steel 316 Stainless Steel		303 Stainless Steel 304 Stainless Steel 316 Stainless Steel Epoxy	
O-Ring Material	Viton®			
Fitting Material	Choose from acetal, brass, or stainless steel			
Recommended Filtration	20 microns or less Optional inline filters available			
Compatible gases	Clean, dry gases compatible with wetted materials			
Output Signal	0-5VDC, Impedance greater than 2.5 KΩ			
External Set-point Signal	0-5VDC, Integrated 2MΩ load			
Internal Set-point Signal	N/A	Front Panel Adjustment	N/A	Front Panel Adjustment
Warm-Up Time	Less than 5 minutes			
Integrated Display	N/A	3½ digit	N/A	3½ digit
Typical Power Consumption	Standard: 12 VDC @ 250 mA (12.5-15 VDC) “E” Suffix: 24 VDC @ 130 mA (22-25 VDC)			
Peak Power Consumption	Standard: 12 VDC @ 400 mA (12.5-15 VDC) “E” Suffix: 24 VDC @ 260 mA (22-25 VDC)			
Electrical Connections	Integrated 36” (92 mm) cable, terminated with: Standard: 6-pin Mini-DIN male (PS/2 Style) D1 Option: 9-pin D-Sub male D2 Option: 15-pin D-Sub male			
Certifications	CE Approved 89/336/EEC (EN 55011 & EN 50082-1) 73/23/EEC Low Voltage Directive			

*Specifications from 10-100% of rated flow. Linearity is best fit straight line. All calibrations performed with air unless otherwise stated on calibration certificate.

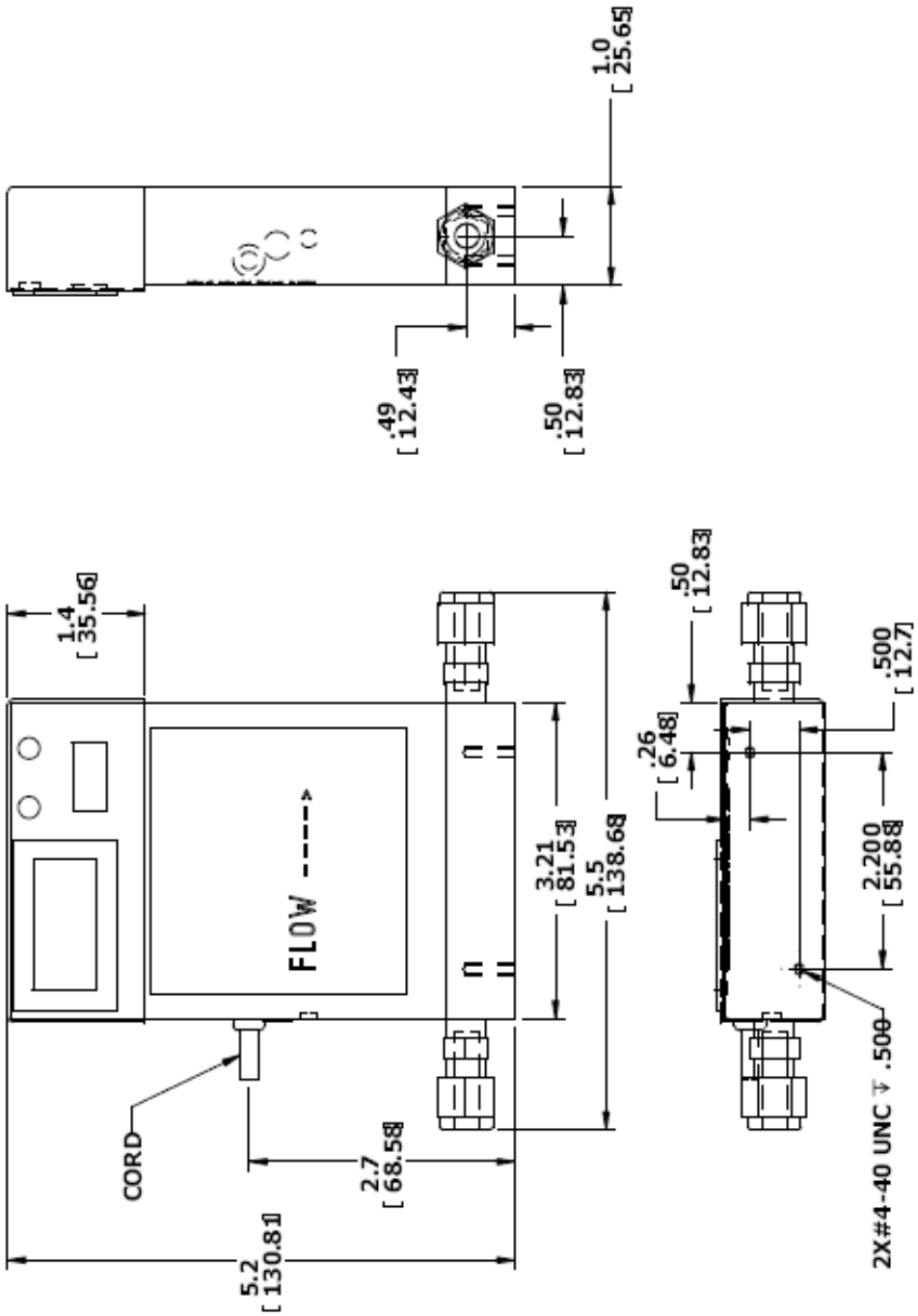
F. Dimensions

ALL DIMENSIONS IN INCHES (MILLIMETERS IN BRACKETS)

FMA 3200/3200ST Series - 1/4" Stainless Fittings Shown



FMA 3400/3400ST Series - 1/4" Stainless Fittings Shown



G. Gas K Factors

Gas	Chemical Symbol	K Factor
Acetylene	C_2H_2	0.589
Air	-	1.000
Argon	Ar	1.438
Butane	C_4H_{10}	0.260
Carbon Dioxide	CO_2	0.739
Deuterium	D_2	1.000
Ethylene	C_2H_4	0.598
Freon 11	CCL_3F	0.330
Freon 12	CCL_2F_2	0.354
Freon 13	$CCLF_3$	0.385
Freon 14	CF_4	0.420
Freon 22	$CHCLF_2$	0.460
Germane	GeH_4	0.570
Helium	He	1.458
Hydrogen	H_2	1.011
Krypton	Kr	1.440
Methane	CH_4	0.721
Neon	Ne	1.443
Nitric Oxide	NO	0.990
Nitrogen	N_2	1.000
Nitrous Oxide	N_2O	0.710
Oxygen	O_2	0.991
Ozone	O_3	0.446
Propane	C_3H_8	0.383
Sulfur Dioxide	SO_2	0.690
Xenon	Xe	1.437

These K Factors are given for reference only and are not intended as a recommendation of application suitability. Accuracy and response will be affected depending on the gas and flow range. Check the compatibility of all wetted materials before using any gas other than the calibration gas for the unit.

H. Troubleshooting Guide

Symptom	Possible Cause	Method of Correction
Clicking noise from controller	Unit in error mode	Check there is sufficient pressure and that the flow path is not restricted or blocked
No response	Unit wired incorrectly	Check wiring is according to Section B5
	Loose connection	Check all connectors and wiring
	Damaged connector pins	Contact Omega Engineering
	Blocked flow path	Check flow path for obstructions.
	Piping leak before sensor	Check all piping and connections.
	Insufficient power	Check the power supply output and increase if necessary
	Output load resistance too low	Ensure the voltmeter or data acquisition system or display has an impedance of greater than of 2.5kohm
	Flow too low for the unit	Ensure that the flow being measured is within the capabilities of the unit
	Unit damaged or faulty	Contact Omega Engineering
Inaccurate control	Particles in flow path	Add filtration before the sensor.
	Flow path obscured	Remove any debris or blockage in the flow path eg. PTFE tape.
	Unit calibrated for a different gas	Check calibration certificate and apply a "K" Factor to readings if necessary.
	Gas composition is variable	Contact Omega Engineering
	Fittings have been changed	Replace the factory installed fittings
	Moisture in gas	Ensure gas is clean and dry
	Insufficient warm-up period	Allow the unit to warm-up for at least 5 minutes.
	Zero drift	Verify the zero and adjust as necessary as explained in Section C
	The gain potentiometer has been adjusted	Contact Omega Engineering
	Unit needs recalibration	Contact Omega Engineering
	Flow too high for the unit	Ensure that the flow being measured is within the capabilities of the unit

Symptom	Possible Cause	Method of Correction
Inaccurate control	Insufficient or varying power	Check the power supply output and increase if necessary
	Insufficient pressure	Ensure the pressure (an differential pressure) is high enough o operate the unit.
	Varying pressure	Check the stability of the pressure regulation and improve if necessary.
	Ambient temperature too high or too low	Place the unit in a suitable environment
	Output load resistance too low	Ensure the voltmeter or data acquisition system or display has an impedance of greater than of 2.5kohm
	Gas temperature too high or too low	Ensure the gas temperature is within the recommended operating range
	Unit damaged or faulty	Contact Omega Engineering
Problems with rezeroing	Gas flow through unit not completely stopped	Ensure there is no flow through the unit. The easiest way to do this is to plug both the inlet and outlet.
	Severe fluctuations in the ambient temperature e.g. unit in direct sunlight	Carry out the rezero procedure in a stable environment
	Unstable power supply	Check the stability and suitability of the power source
	Insufficient warm-up period	Allow the unit to warm-up for at least 5 minutes.

WARRANTY/DISCLAIMER

OMEGA ENGINEERING, INC. warrants this unit to be free of defects in materials and workmanship for a period of **13 months** from date of purchase. OMEGA's WARRANTY adds an additional one (1) month grace period to the normal **one (1) year product warranty** to cover handling and shipping time. This ensures that OMEGA's customers receive maximum coverage on each product.

If the unit malfunctions, it must be returned to the factory for evaluation. OMEGA's Customer Service Department will issue an Authorized Return (AR) number immediately upon phone or written request. Upon examination by OMEGA, if the unit is found to be defective, it will be repaired or replaced at no charge. OMEGA's WARRANTY does not apply to defects resulting from any action of the purchaser, including but not limited to mishandling, improper interfacing, operation outside of design limits, improper repair, or unauthorized modification. This WARRANTY is VOID if the unit shows evidence of having been tampered with or shows evidence of having been damaged as a result of excessive corrosion; or current, heat, moisture or vibration; improper specification; misapplication; misuse or other operating conditions outside of OMEGA's control. Components in which wear is not warranted, include but are not limited to contact points, fuses, and triacs.

OMEGA is pleased to offer suggestions on the use of its various products. However, OMEGA neither assumes responsibility for any omissions or errors nor assumes liability for any damages that result from the use of its products in accordance with information provided by OMEGA, either verbal or written. OMEGA warrants only that the parts manufactured by the company will be as specified and free of defects. OMEGA MAKES NO OTHER WARRANTIES OR REPRESENTATIONS OF ANY KIND WHATSOEVER, EXPRESSED OR IMPLIED, EXCEPT THAT OF TITLE, AND ALL IMPLIED WARRANTIES INCLUDING ANY WARRANTY OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE HEREBY DISCLAIMED. LIMITATION OF LIABILITY: The remedies of purchaser set forth herein are exclusive, and the total liability of OMEGA with respect to this order, whether based on contract, warranty, negligence, indemnification, strict liability or otherwise, shall not exceed the purchase price of the component upon which liability is based. In no event shall OMEGA be liable for consequential, incidental or special damages.

CONDITIONS: Equipment sold by OMEGA is not intended to be used, nor shall it be used: (1) as a "Basic Component" under 10 CFR 21 (NRC), used in or with any nuclear installation or activity; or (2) in medical applications or used on humans. Should any Product(s) be used in or with any nuclear installation or activity, medical application, used on humans, or misused in any way, OMEGA assumes no responsibility as set forth in our basic WARRANTY/DISCLAIMER language, and, additionally, purchaser will indemnify OMEGA and hold OMEGA harmless from any liability or damage whatsoever arising out of the use of the Product(s) in such a manner.

RETURN REQUESTS/INQUIRIES

Direct all warranty and repair requests/inquiries to the OMEGA Customer Service Department. BEFORE RETURNING ANY PRODUCT(S) TO OMEGA, PURCHASER MUST OBTAIN AN AUTHORIZED RETURN (AR) NUMBER FROM OMEGA'S CUSTOMER SERVICE DEPARTMENT (IN ORDER TO AVOID PROCESSING DELAYS). The assigned AR number should then be marked on the outside of the return package and on any correspondence.

The purchaser is responsible for shipping charges, freight, insurance and proper packaging to prevent breakage in transit.

FOR **WARRANTY** RETURNS, please have the following information available BEFORE contacting OMEGA:

1. Purchase Order number under which the product was PURCHASED,
2. Model and serial number of the product under warranty, and
3. Repair instructions and/or specific problems relative to the product.

FOR **NON-WARRANTY** REPAIRS, consult OMEGA for current repair charges. Have the following information available BEFORE contacting OMEGA:

1. Purchase Order number to cover the COST of the repair,
2. Model and serial number of the product, and
3. Repair instructions and/or specific problems relative to the product.

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